1.4 Base catch limits for the krill fishery

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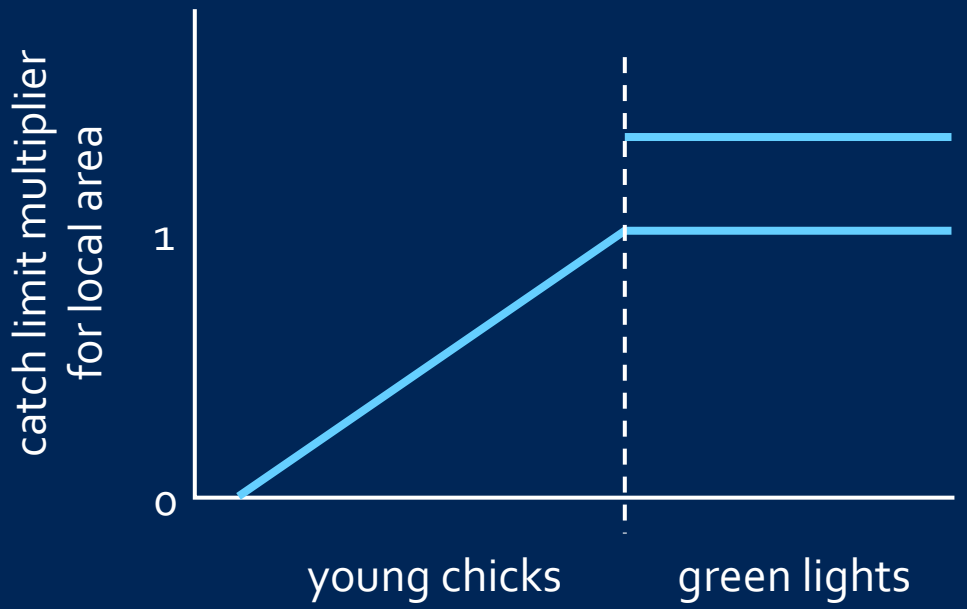
Southwest Fisheries Science Center
Antarctic Ecosystem Research Division

TOR QUESTIONS: 5, 6



1.6 Wrap up

1.5 Adjust up

1.4 Base catch limit

1.6 Adjust down

1.2 & 1.3 Background

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Base catch limit (b) for local area i in year t

$$b_{i,t} = L_t \times \alpha_i$$

regional catch limit estimated from stock assessment and application of krill decision rules

"allocation fractions" define default subdivision of regional catch limit among local areas

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CCAMLR's current approach

BASIC ELEMENTS

- Forward projection with pre-specified recruitment variability
- Find harvest rates such that
  - Pr(SSB < 0.2 × median SSB0) = 0.1 over a 20-year harvesting period (krill)
  - Pr(SSB ≥ 0.75 × median SSB0) = 0.5 at the end of the harvesting period (predators)
- Catch limit = harvest rate × synoptic biomass estimate

FLAWS

- Philosophical
  - time-series data not used
  - recruitment variability not estimated
  - SSB0 may not be relevant
- Practical
  - new synoptic surveys unlikely
  - strict application of current decision rules implies catch = 0 given observed recruitment variability

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SSB = spawning stock biomass
SSB0 = pre-exploitation SSB

Krill assessment 1

DATA (# OF TIME SERIES)

- biomass indices
  - acoustics (2)
  - research net tows (4)
- size compositions
  - research net tows (4)
  - fishery (1)
- catches (1)

ESTIMATED PARAMETERS (#)

- growth (3)
- natural mortality (1)
- recruitment (4 + nyears)
- age-specific selectivity (7 × 2)
- year-specific fishing mortality (1 + nyears fishing)

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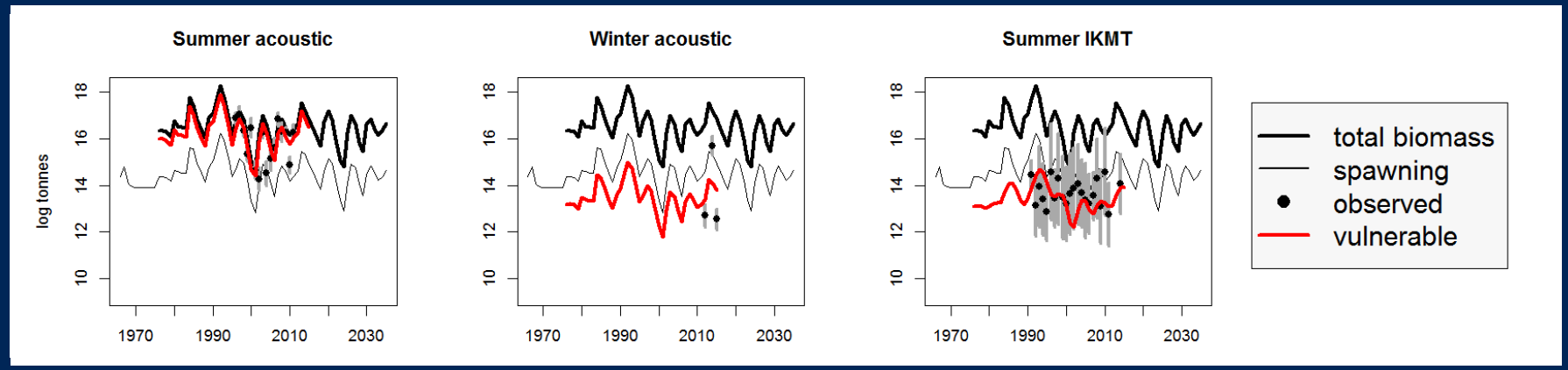
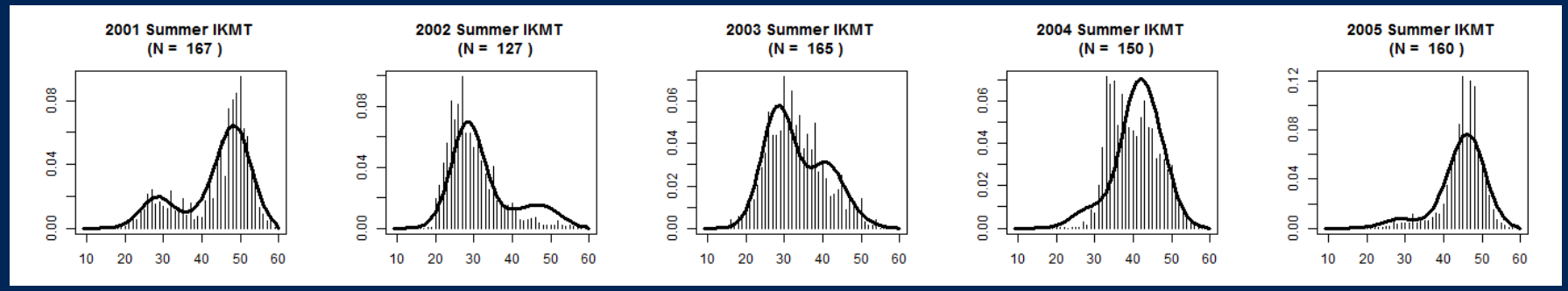
Krill assessment 2



+ similar fits to 3 other net series



+ similar fits to 3 other net series and size comps. from fishery

+ near-perfect fit to fishery catches

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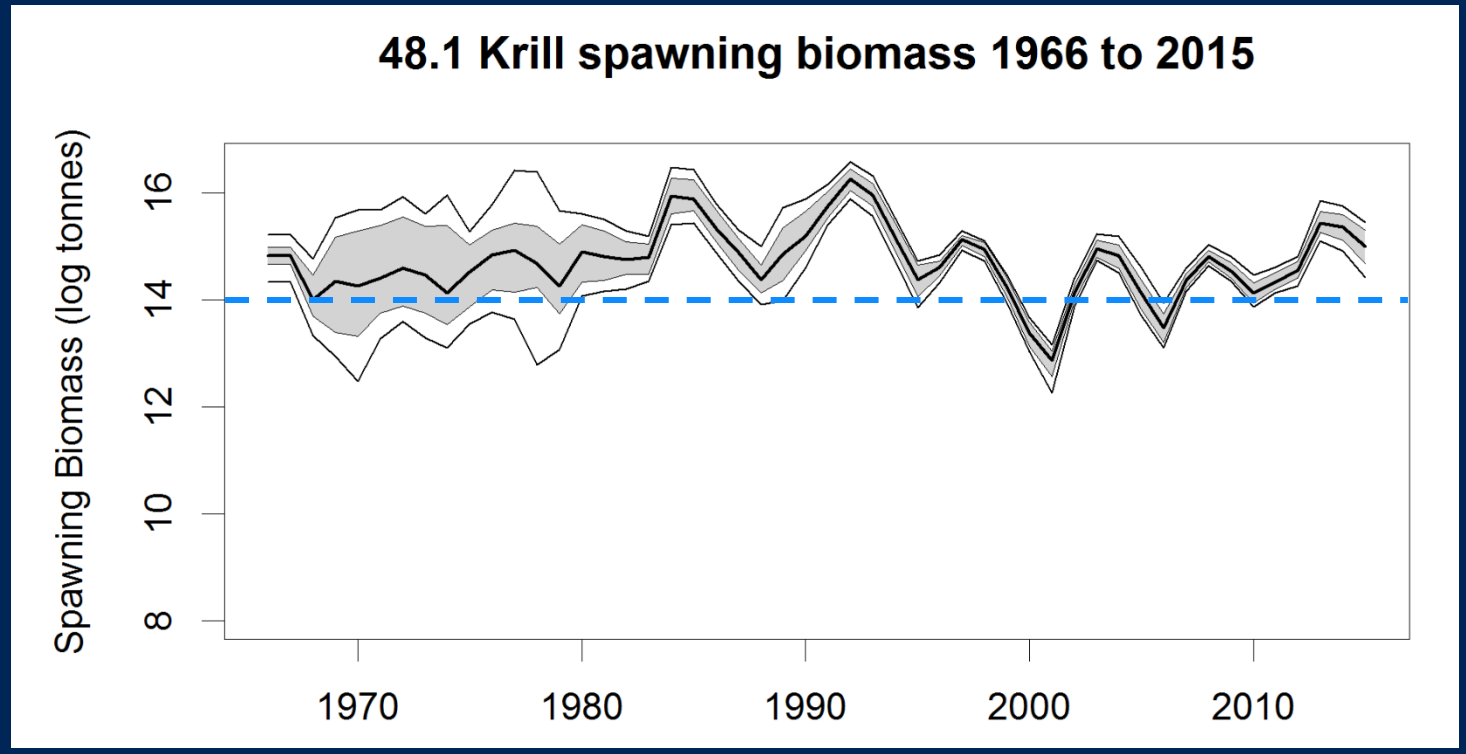
Krill assessment 3



- Post-1976 decline in krill (Atkinson et al. 2004) has not continued

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CIE review

- Estimate fewer parameters and use sensitivity analyses to characterize uncertainty
- Index SSB with population fecundity rather than adult biomass
- Revise recruitment series in forward projections
- Revise *alternative* decision rules to evaluate escapement throughout 20-yr fishing period rather than at end of the period

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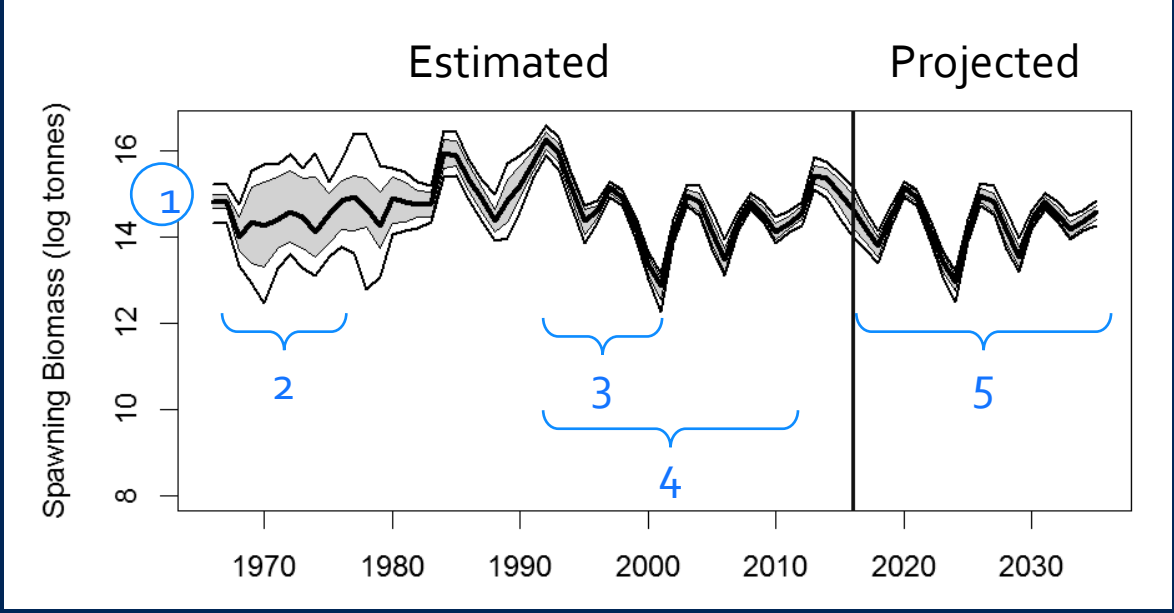
Alternative reference points and catch limits



Ref. point	*L*	"trigger"
1	0	predators
2	517 kt < *L* < 647 kt	predators
3	0	predators
4	647 kt < *L* < 862 kt	TBD
5	862 kt < *L* < 1293 kt	krill

Note: Refined estimates of *L* to be developed in near future.

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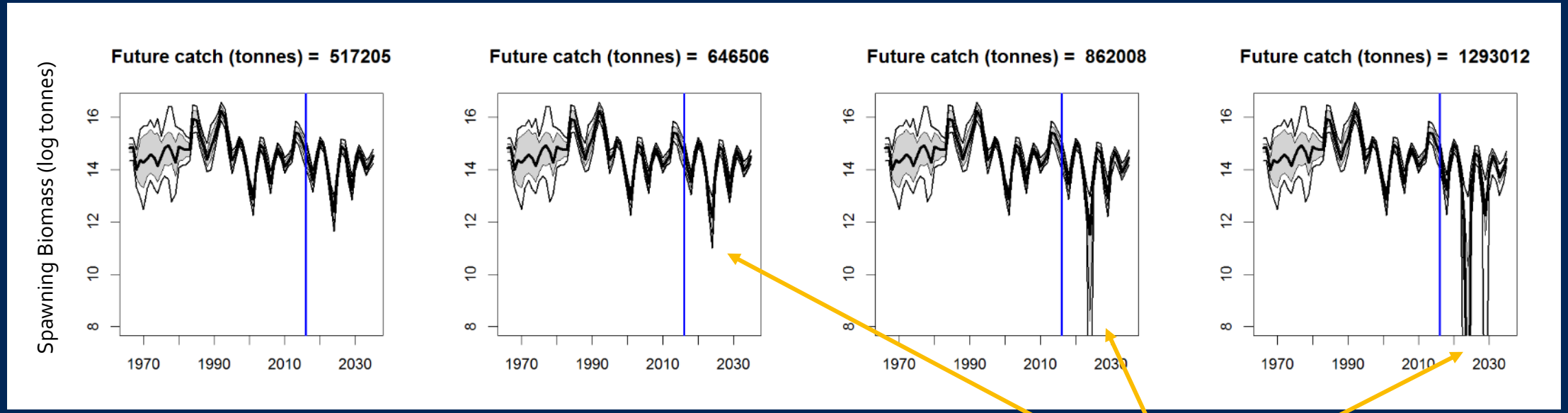
But need something more …



Catches above 620 kt are risky without spatial management (Watters et al. 2013)

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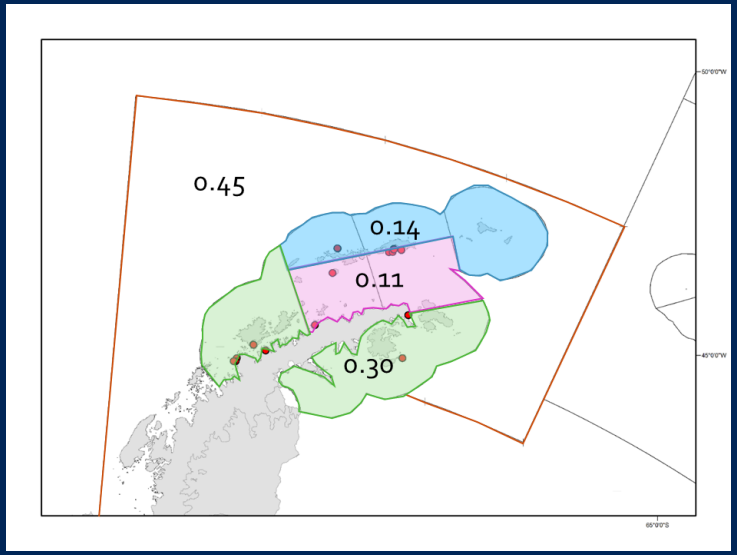
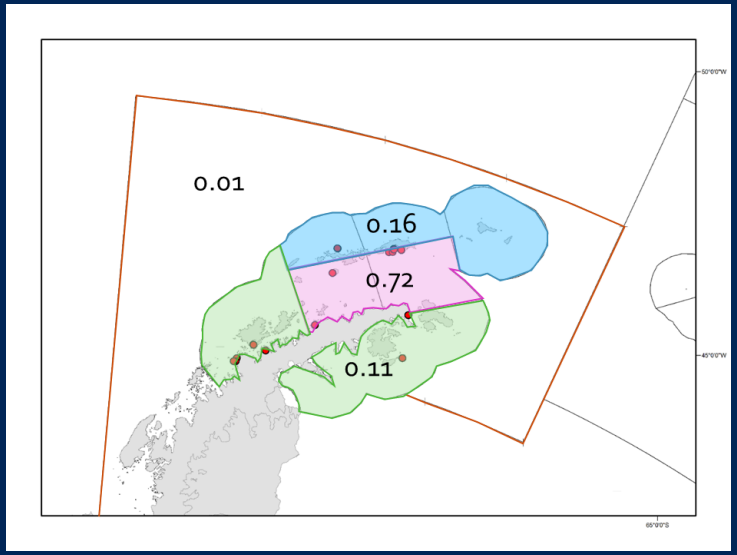
Candidate allocation fractions

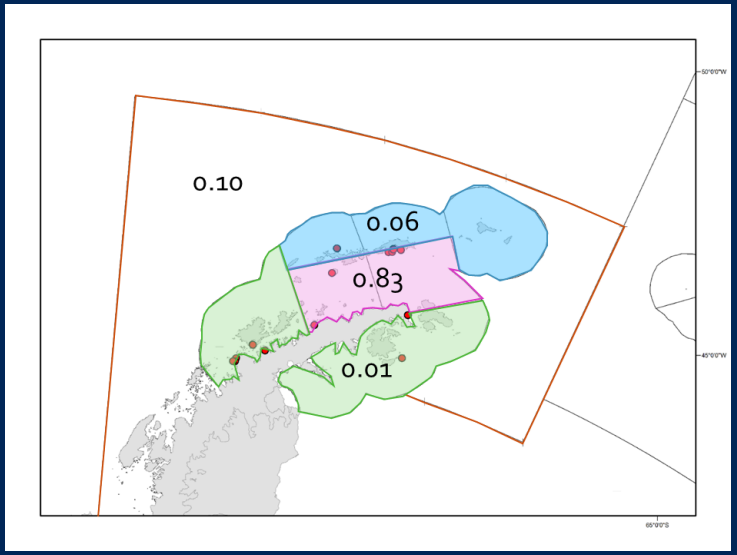
"Demand" from Watters et al. 2013



Recent catches (2009-2015)



Standing winter biomass (U.S. AMLR)



- options like "demand" less risky to predators (Watters et al. 2013)
- options like "demand" most risky and less acceptable to fishing vessels
- choice determined by consensus on how to address tradeoffs

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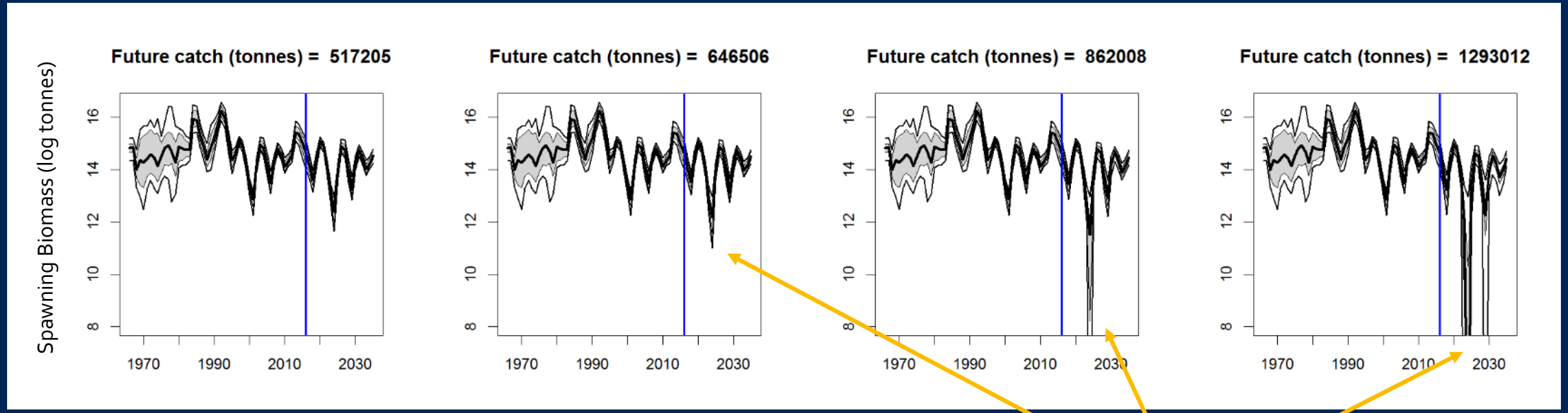
Something more still needed …



Results from meta-analysis show that local catches on order of 10^5 t have negatively impacted penguin performance

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Adjusted catch limit *(l)*

regional catch limit

$$b_{i,t} = L_t \times \alpha_i$$

allocation fraction

$$l_{i,t} = b_{i,t} \times \varepsilon_{i,t}$$

"catch limit multiplier" adjusts base catch limit in local area using ecosystem observations

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Other cool stuff we have done[1] or in mind[2]

- [1]Using assessment model to consider frequency and timing of krill surveys and [2]frequency of assessments
- [2]Fitting to Palmer LTER data, size compositions from predator diet studies, and krill-survey data from the South Orkney Is. and South Georgia
- [2]Age compositions (!) of krill in archived net samples
- New post-doc will re-tool and re-fit ecosystem model – [2]can be used to re-evaluate allocation fractions

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Answers to TOR questions

5. Using an integrated assessment model to make inferences about the dynamics of the krill population and exploring reference points are more sensible in changing ecosystem

6. Integrated assessment model and appropriate decision rules provide framework for using all relevant data on krill to advise on regional catch limit, with subsequent allocation among local areas based on tradeoff between risks to predators and risks to fishery

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STRENGTHS

- only statistical assessment model (fitting multiple data sets) available for krill
- long history of working on allocation fractions

CHALLENGES

- making CCAMLR Members comfortable with krill assessment
- consensus on a reasonable set of allocation fractions
- pressure to agree on regional catch limit without allocation fractions and local area adjustments

STRATEGIES

- CIE review
- focus on results from ecosystem modeling and meta-analysis
- advise State Dept. **not** to join consensus on increasing regional limit without "protections"

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